CLAIMS

What is claimed is:

1. A process for improved performance in at least one fuel cell, having a loss in power output of at least 5% of an initial power output, wherein the fuel cell comprises a cathode, an anode, an anode chamber, a cathode chamber, a fuel comprising an anolyte that flows through the cell, and a catholyte gas, wherein the fuel cell is connected to an external load, and wherein the process comprises:

(a1) taking the load off the fuel cell; and

(a2) applying an external electric field from an external power source to the fuel cell to reverse electrochemical reactions until at least 5.0% of the lost power output is regained.

2. The process of claim 1 wherein the applying an electric field from an external power source to the fuel cell to reverse electrochemical reactions occurs by, either:

(a2a) cycling between a minimum voltage and a maximum voltage applied to the fuel cell until a maximum current is reached;

(a2b) cycling between a minimum current and a maximum current applied to the fuel cell until a minimum voltage is reached;

(a2c) applying an alternating voltage (AC voltage) until a maximum current is reached;

(a2d) applying an alternating current until a maximum voltage is reached across the fuel cell;

(a2e) applying a constant voltage until a maximum current is reached; or

(a2f) applying a constant current until a minimum voltage is reached.

3. The process of claim 1 wherein the power source is selected from the group consisting of batteries, capacitors, solar cells, and another fuel cell.

4. The process of claim 1 wherein the fuel cell is a direct feed fuel cell.

5. The process of claim 4 wherein the fuel is in the liquid or vapor phase. 6. The process of claim 5 wherein the fuel is an alcohol or an ether.

7. The process of claim 6 wherein the alcohol is methanol or ethanol.

8. The process of claim 6 wherein the ether is diethyl ether.

9. The process of claim 1 wherein at least 25% of the lost power output is recovered.

10. The process of claim 9 wherein at least 50% of the lost power output is recovered.

11. The process of claim 2 wherein the voltage was cycled between about 0V and about 2.3 V.

12. The process of claim 2 wherein the current was cycled between about 0 to about 2 A/cm^2.

13. The process of claim 2 wherein the AC voltage amplitude is about 0 to about 3V per cell, and the frequency is about 16 to about 500 Hz.

14. The process of claim 2 wherein the AC current amplitude is about 0 to about 2 A/cm^2 root mean squares (rms), and the frequency is about 16 to about 500 Hz.

15. The process of claim 1 wherein before step (a2), the process further comprises:

(b) clearing the fuel cell of any liquid present therein to achieve a resistance of at least about 10% higher than the value before clearing the cell of any liquid; and

(c) starting the flow of anolyte through the fuel cell.

16. The process of claim 15 wherein the clearing of the fuel cell of any liquid present therein is achieved by:

(b1) stopping the flow of anolyte through the fuel cell; and

(b2) providing a continuous flow of catholyte gas through the fuel cell for at least 30 seconds;

17. The process of claim 15 further comprising:

(d) oxidizing the residual fuel in the fuel cell.

18. The process of claim 17 wherein oxidizing the residual fuel in the fuel cell is achieved by breaking the electrical connection between the cathode and anode.

19. The process of claim 17 wherein oxidizing the residual fuel in the fuel cell is achieved by applying a constant voltage in the range of about 0.005 V to about 0.8 V per cell.

20. The process of claim 15 wherein before step (c), the anode chamber is purged with air.

21. The process of claim 15 wherein before step (c), the anode chamber is purged with nitrogen.

22. The process of claim 15 wherein after step (a1) the anode chamber of the fuel cell is purged with water.

23. The process of claim 17 wherein before step (c) the anode chamber of the fuel cell is purged with air.

24. The process of claim 15 wherein the before step (c), the cathode chamber is purged with air.

25. The process of claim 20 wherein the cathode chamber is purged with air.

26. The process of claim 24 or 25 wherein the cathode chamber is purged with air for at least 10 seconds.

27. The process of claim 24 wherein the anode chamber is purged with air after the cathode chamber is purged.

28. The process of claim 24 wherein the anode chamber is purged with nitrogen after the cathode chamber is purged.

29. The process of claim 27 wherein the air comprises exhaust air from the cathode chamber.

30. The processes of claim 27, 28, or 29 wherein the anode chamber is purged for about 2-15 minutes.

31. The processes of claim 30, wherein the anode chamber is purged for about 5-15 minutes.

32. The processes of claim 31, wherein the anode chamber is purged for about 10-15 minutes.

33. The process of claim 15 wherein the resistance reached is at least about 20% higher than the value before clearing the cell of any liquid.

34. The process of claim 33 wherein the resistance reached is about 100 to about 500% higher than the value before clearing the cell of any liquid.

35. The process of claim 1 wherein fuel cells are in a stack.

36. The process of claim 15 wherein fuel cells are in a stack.

37. The process of claim 17 wherein fuel cells are in a stack.